

## VEHICLE HEATING AND AIR CONDITIONING MODULES

### CROSS REFERENCE TO RELATED APPLICATION

[0001] The present application is related to provisional application no. 60/271,084 filed 23 February 2001.

### BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention:

[0003] The present invention relates to motor vehicle cabin climate control and more particularly to interoperative, easily maintained cabin and engine compartment modules, which are used to implement cabin heating and cooling in an efficient and reliable manner.

[0004] 2. Description of the Problem:

[0005] Combined systems for heating, ventilation and air conditioning (HVAC) have become an industry norm for automobiles and trucks. Among the features common to most if not all such systems are, a heater core, a blower to force air through the heater core, an evaporator for cooling air, distribution duct work, and a plurality of flow directing doors controlling the source of intake air, the route of the air through the system and the distribution points of the air into the cabin. The construction, arrangement, packaging and control of these elements has a number of ramifications for unit efficiency, cost and ease of manufacture and maintenance, space requirements for installation and passenger comfort.

[0006] Passenger cabin heating and windshield defrosting is provided by forcing air through interstices in a heater core, which, in vehicles with liquid cooled engines, use circulating engine coolant as a source of heat. Contemporary HVAC systems often provide no cutoff valve for interrupting coolant circulation through the core. Instead, internal air flow control doors cut off the core from air circulation when heat is not desired. Coolant cutoff valves have proven relatively unreliable in many applications, and eliminating them has produced maintenance savings. Heater cores themselves are an occasional

maintenance problem, being prone to corrosion and leakage with long term use. The positioning and manner of installation of heater cores has made them difficult to replace.

[0007] Combined heating, ventilation and cooling systems have been adopted to reduce the costs of duct work, since only one set of distribution channels is required. Such an arrangement, combined with the absence of a heater core cutoff valve, contributes to greater complexity in the arrangements for air flow control. Rapid cooling of the vehicle passenger compartment when a vehicle is first turned on is often achieved by recirculating cabin air rather than drawing in outside air. Some defogging regimens call for both cooling the air, to remove moisture, and heating the air to clear interior surfaces of the vehicle greenhouse. Flow control doors must be positionable to draw air from either outside or inside the passenger compartment, to direct air through either or both the heater core and the evaporator and then to mix the air before it is directed against the glass. Finally, vent doors must provide for distribution of air to the desired locations. Kinematic positioning movements control the position of various vent and flow control doors and to deliver adequate air flow to the desired zone.

[0008] Individual products of the motor vehicle industry are frequently sold world wide. What were once considered North American trucks have found markets in South America, Australia and South Africa, among other places. Australia and South Africa use right hand drive vehicles and an HVAC system intended for a vehicle to be sold in both left hand and right hand drive countries can cost less in tooling if the components fit either type of vehicle.

#### SUMMARY OF THE INVENTION

[0009] According to the invention there is provided a heating, ventilation and air conditioning system for a vehicle. The system includes an engine compartment module having a base formed for positioning on at least two locations on a dash panel, an outside air inlet, a secondary air inlet for communication with the passenger compartment, an air outlet and defining an air transport conduit connecting the outside air inlet or the secondary air inlet with the air outlet. Downstream from the engine compartment, on the opposite major surface of the dash panel, is a passenger compartment module having a slide in slot for a heater core, an inlet for communication with the air outlet from the engine compartment module, an air manifold, a panel exhaust from the air manifold, a defrost exhaust from the air manifold, a compartment door providing

access to the slide in friction slot, and an air channel from the inlet to the air manifold. A heater core is positioned in the slide in slot. A temperature blend door is positioned in the air channel on a pivoting mount allowing movement of the temperature blend door to various positions controlling the proportion of air flow through the air channel diverted through the heater core. A pulse count actuator is coupled to the temperature blend door for positioning the temperature blend door. A vent door is mounted on a pivoting mount and positionable in the air manifold for diverting air flow through the panel exhaust. A defrost door is mounted on a second pivoting mount and positionable in the air manifold for diverting air flow through the defrost exhaust. A kinematic movement including a pulse count actuator provides for positioning the vent and defrost doors. A blower is situated along the air channel of the passenger compartment module upstream from the slide in friction slot. An evaporator is mounted in the engine compartment module.

[0010] Additional effects, features and advantages will be apparent in the written description that follows.

#### BRIEF DESCRIPTION OF THE DRAWINGS

[0011] The novel features believed characteristic of the invention are set forth in the appended claims. The invention itself however, as well as a preferred mode of use, further objects and advantages thereof, will best be understood by reference to the following detailed description of an illustrative embodiment when read in conjunction with the accompanying drawings, wherein:

[0012] Fig. 1 is a perspective view of a truck on which the heating, ventilation and air conditioning system of the invention is installed;

[0013] Fig. 2 is a side elevation of the heating, ventilation and air conditioning system installation in accordance with a preferred embodiment of the invention;

[0014] Fig. 3 is a perspective view of an evaporator or engine compartment module of the preferred embodiment;

[0015] Fig. 4 is a schematic view of the heating, ventilation and air conditioning system of the

preferred embodiment;

[0016] **Fig. 5** is a perspective view of the heating or passenger compartment module of the preferred embodiment;

[0017] **Figs. 6A-B** illustrate in perspective and elevation a kinematic movement for controlling the mode of the panel and defrost ventilation control doors in the preferred embodiment;

[0018] **Fig. 7** is a perspective view of a blower and scroll assembly for a heater module;

[0019] **Fig. 8** is a perspective view of an evaporator; and

[0020] **Fig. 9** is a control schematic for the heating, ventilation and air conditioning system.

#### DETAILED DESCRIPTION OF THE INVENTION

[0021] Referring now to the figures and particularly to **Fig. 1**, a truck **10** is shown on which the heating, ventilation and air conditioning system of the invention is advantageously installed. Truck **10** comprises a cab **11** which rests on a frame **12**. An engine compartment **14** is separated from a passenger compartment **15** by a dash panel **16**. Dash panel **16** includes a pair of mating positions **18** toward each side of the truck **10**, one being visible on the driver's side **42** of truck **10**. A second position is hidden from view behind an engine compartment module **22**. Mating positions **18** include openings **20** through the dash panel **16** through which a steering column **46** may pass or which may be used as an channel to direct air through.

[0022] An evaporator or engine compartment module **22** is mounted over the mating position **18** not required for steering column **46**, i.e. on the side opposite to the driver's side **42** of the vehicle. Engine compartment module **22** includes an air intake **24** and is positioned on the dash wall **16** adjacent to, but extending from the opposite major face of dash panel **16**.

[0023] Referring now to **Fig. 2**, a heating, ventilation and air conditioning (HVAC) system **17** for a motor vehicle is shown. HVAC system **17** comprises two major modules, an engine compartment module **22**, which includes an evaporator for air cooling, and a passenger compartment module **26** which has a heater core for heating air. Both modules are supported on dash panel **16**, one on each of the opposed major surfaces of the dash panel. Modules **22** and **26** communicate with each other by way of openings through the dash panel **16**. Extending from the bottom of engine compartment module **22** are two drains, a precipitation drain **34** and a condensate drain **36**.

[0024] Passenger compartment module **26** includes a coolant drain **60** (See **Fig. 4**), providing an escape for coolant loss from a leaking heater core. A panel vent **30** and a defrost vent **28** are located adjacent one another along the top of passenger compartment module **26**. A conduit **38** distributes air to the floor from a manifold internal to module **26**. Panel **41** is attached to module **26** by conventional fasteners and is removable to provide ready access to the interior of module **26** for repairs, particularly replacement of a heater core or a blower. The heater core is located under a end fitting region **45** in panel **40** which helps locate the heater core firmly within module **26**.

[0025] Referring now to **Fig. 3**, engine compartment module **22** is illustrated in greater detail. Engine compartment **22** is constructed from two half sections **50** and **52**, which are attached to one another along a series of projecting flanges **54** by conventional fasteners. Similar flanges **56** extend from a back edge of the module allowing attachment of the module to the dash panel. A recirculation control door **58** is located inside of module **22** visible through outside air inlet **24**. A pulse actuator **48**, hung from the outside of the module, controls the position of recirculation control door **58**, which can be rotated to close inlet **24**.

[0026] Referring now to **Fig. 4**, the major internal elements of HVAC system **17** are shown in a schematic view, which also illustrates by a series of arrows the flow of air through the system. Outside air enters HVAC system **17** by an outside air inlet **24**, provided recirculation control door **58** is positioned away from the inlet. Recirculation control door **58** is mounted on a rotatable axle **62**, allowing the door to be moved between positions fully closing inlet **24**, door **58** moved upwardly against stop **25**, and a position with door **58** fully retracted from inlet **24** allowing outside air to enter the system freely. When door **58** is in the closed position air is recirculated from the passenger cabin manifold **84** and channels **63** and **250**.

[0027] Through inlet **24** air enters a channel **64** from which there are two drains, a precipitation drain located ahead of filter **66** and evaporator **70**, and a condensation drain **36**, which is downstream in the air path from the evaporator. Filter **66** and evaporator **70** are mounted in frames **68** and **72**, respectively. From evaporator **70** air is drawn further down channel **64** to a blower **76**, which includes a D.C. motor and a centrifugal fan, the details of which are conventional. Blower **76** pushes air out along a heater module **26** air channel **74**, which passes next to a heater core plenum **80**. Air may be directed through or by plenum **80** by the position of a temperature blend control door **78**, which is pivotally **79** mounted along channel **74** and which may be moved between positions **A** and **B** at which positions it closes channel **74** and access to plenum **80**, respectively.

[0028] With temperature blend door **78** positioned at position **A**, and air flow thereby diverted through plenum **80**, the flowing air encounters and passes through heater core **82** before returning to channel **74** on the downstream side of door **78**. Heater core **82** typically will not have a shut off valve, and accordingly, coolant from an engine will, if the vehicle is on, be flowing through the core. Normally the air will draw heat from heater core **82**, which functions as a heat exchanger. When module **26** is opened or partially disassembled, heater core **82** may be slid into and out of a slot **81**, allowing ready replacement of the core if required. Door **78** extends from sides of pivot mount **79**, and when positioned as indicated by the letter **B**, it closes off plenum **80** on both sides, preventing air from contacting heater core **82**.

[0029] Downstream from plenum **80** is located an air distribution manifold **84**. Air may be discharged from manifold **84** through a panel vent **30**, a defrost vent **28**, or to floor vents by channel **300**. The direction of air is set by two ventilation control doors, a panel vent door **86** located upstream from defrost vent door **88**. Doors **86** and **88** are mounted on rotatable axes **87** and **89**, respectively. Doors **86** and **88** may be positioned to direct air into channel **300** for distribution to the floor conduits.

[0030] Referring now to **Fig. 5**, an alternative, perspective view in partial section of heater module **26** is shown. Heater core **82** connects to an engine coolant system by coolant circulation pipes **90**, which extend through an opening in the dash panel **16**. Recirculation air can escape manifold **84** back to the engine compartment module **22** by a vent **96**. Heater core **82** rests in a slot **81** formed in part from the top of a blower/scroll subassembly **92**.

**[0031]** All air flow control doors, including recirculation control door **58**, temperature blend control door **78**, panel vent door **86** and defrost vent door **88**, are positioned using pulse actuators, such as the pulse actuator **100** illustrated in **Fig. 6A**. A kinematic movement controlling the mode of each of the flow or ventilation doors is provided. A kinematic movement for vent door **30** and the defrost door **28** is illustrated as it is the most complex of the three systems provided. In the case of the temperature blend door and recirculation door, that portion of the system **98** depicted in **Figs. 6A-B** used to position the vent door **86** suffices to effect position control. Accordingly, the kinematic movements controlling the recirculation door and temperature blend door are not described in detail. In all of the kinematic movements, a pinion gear directly or indirectly engages a cam follower, which is in turn attached to the axle on which a flow or ventilation door is mounted. **Figs. 6A-B** are specifically directed to the kinematic arrangement **98** for the panel vent and defrost vent control doors **86** and **88**, but are representative of the remaining, simpler kinematic mechanisms for the other doors. In **Fig. 6B** the pulse actuator **100** has been removed to more clearly illustrate gearing system.

**[0032]** Pulse actuator **100** turns a pinion gear **102** which includes, around its circumference, smooth regions **101** and toothed regions **103**, which engage toothed regions of a following gear **104**. Gear **102** has mounted thereto a grooved cam **190** with a cam groove **192** is formed. A cam follower **108** is coupled to the cam **190** by a pin **194** which extends into the groove **192**. Cam follower **108** is attached to axle **87**, so that as gear **102** rotates, and pin **194** tracks the moving groove **192**, axle **87** rotates back and forth, resulting in the repositioning of vent door **86**. Substantially identical arrangements provide for the positioning of the temperature blend control door **78** and the recirculation door **58**.

**[0033]** Kinematic movement **98** is extended to provided coordinated control of the defrost door **88** with the panel vent door **86**, thus requiring only one pulse actuator for the control of both doors. Control of the defrost door **88** depends from a gear **104**, which engages pinion gear **102** along a portion of its circumference **105**. A cam **180** with cam groove **182** depend from gear **104**. A cam follower **106** includes a pin fitted into groove **182** so to move axle **89**, which is attached to the cam follower **180**. Axle **89** moves back and forth moving the defrost door **88** between closed and open positions following movement of the cam follower **106**. By appropriate arrangement of the geared regions, and shape of the grooves **192** and **182**, the movements of door **88** and door **86** are coordinated with one another so that the doors are appropriately positioned for ventilation of the cabin, directing air onto the windshield **32** or to the floor. Only

one motor is required for coordinating the positioning of both doors. At engine start up the system is initialized to the last mode selected.

**[0034]** Fig. 7 illustrates blower/scroll subassembly **92**. A pulse actuator **111** may be positioned as indicated on the side of the assembly for connection to the pivot axle for temperature blend control door **78**.

**[0035]** Fig. 8 better illustrates an evaporator **70**, which has a plate fin evaporator coil with block style fittings **110** and **112**.

**[0036]** Fig. 9 illustrates the coolant circulation in heater core **82**. Coolant enters a manifold **138** from whence it is distributed among a plurality of tubes **140**. Coolant circulates outwardly in the tubes and returns by return conduits which, are under the outward flow section, to a return manifold under manifold **138**.

**[0037]** Fig. 10 illustrates a control arrangement for HVAC system **17**, including driver controls **116**. These controls may or may not include a cabin thermostat. Controller **114** output signals include a variable low voltage D.C. control signal to a linear power module **118**, operating as a variable resistor, which in turn controls blower **76**. Further control signals include outputs to pulse count actuator **100** for the vent and defrost control doors, to pulse count actuator **111** for the temperature blend control door and to pulse count actuator **48** for the recirculation control door. Depending upon the inputs provided by the driver and vehicle conditions, controller **114** determines the appropriate positions for each of the pulse actuators and the blower speed.

**[0038]** The invention provides a space efficient, widely applicable truck HVAC system, which is easily maintained and efficient. While the invention is shown in only one of its forms, it is not thus limited but is susceptible to various changes and modifications without departing from the spirit and scope of the invention.